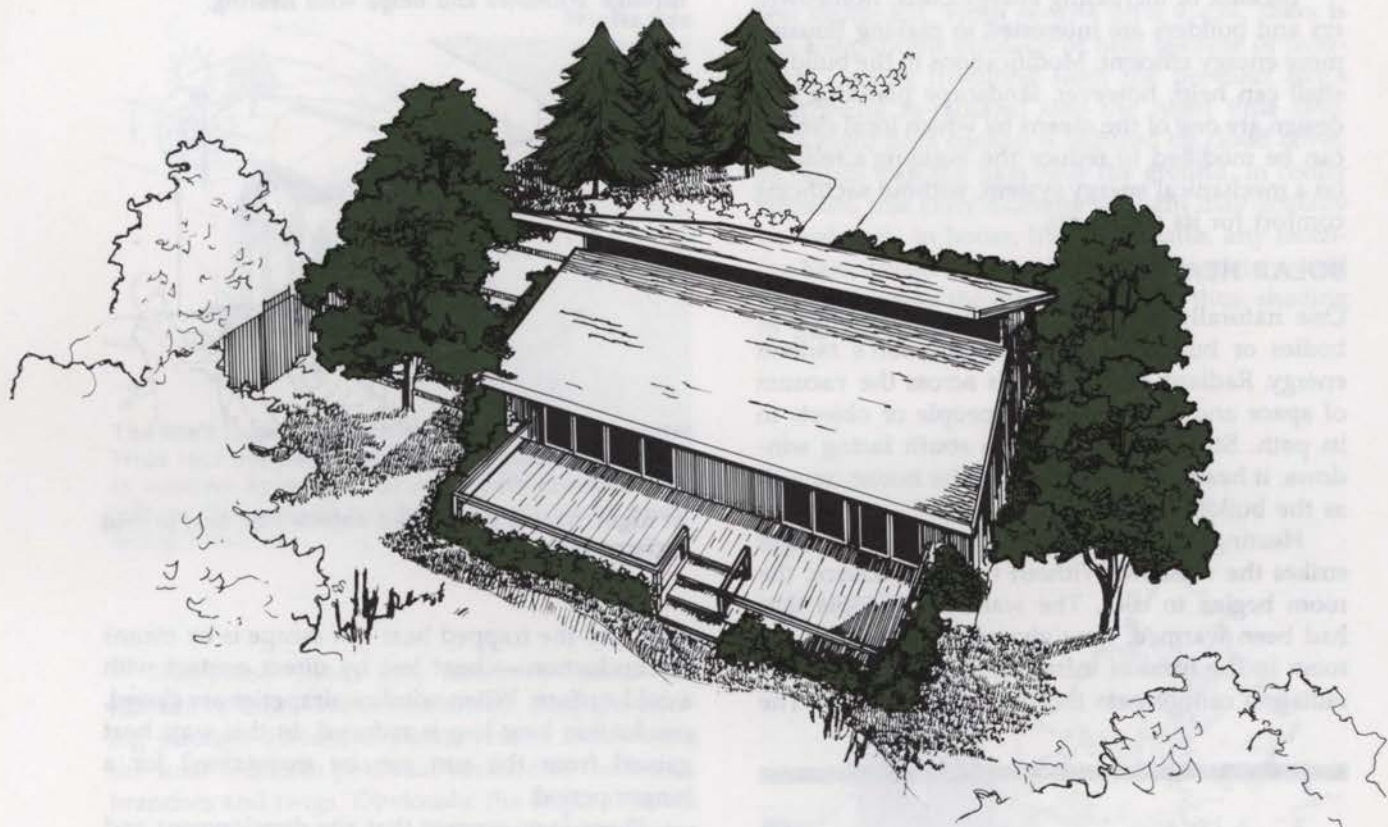


# COUNCIL NOTES



## B3.1 LANDSCAPING FOR ENERGY CONSERVATION



Our early ancestors sought warmth in the sun, protection in caves, and cooling breezes during humid spells. By carefully selecting building sites and building materials, they took advantage of positive climatic forces. In so doing, they were able to increase their physical comfort and reduce the time and effort required to find and store energy. Today, people still strive to keep warm when it's cold and cool when it's hot.

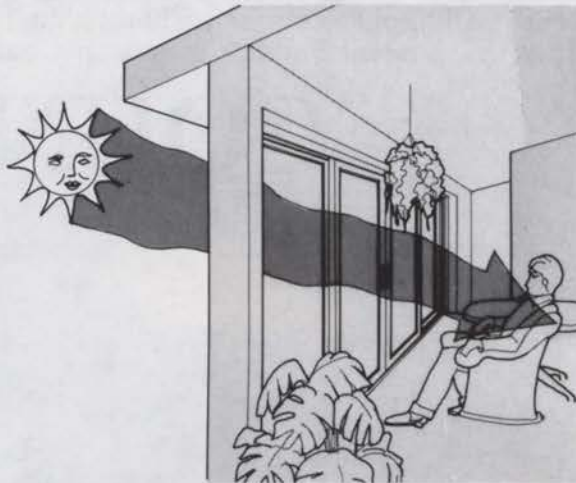
When energy was inexpensive and abundant, the natural forces that affected our comfort could be modified by mechanical heating and cooling systems. Solar radiation, temperature, wind, and humidity — natural forces that change with local conditions — were ignored. The homeowner was protected by the building shell.

Because of increasing energy costs, homeowners and builders are interested in making housing more energy efficient. Modifications in the building shell can help; however, landscape planning and design are one of the means by which local climate can be modified to reduce the building's reliance on a mechanical energy system, without sacrificing comfort for its occupants.

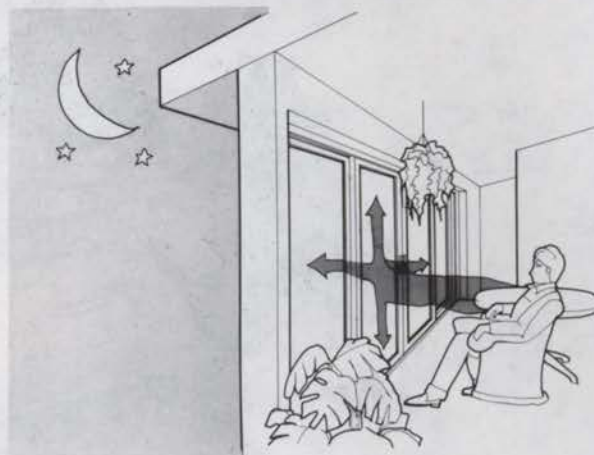
## SOLAR HEATING

One naturally occurring means of warming our bodies or buildings is to trap the sun's radiant energy. Radiant energy travels across the vacuum of space and is absorbed by people or objects in its path. Streaming in through south facing windows, it heats the objects inside the house, as well as the building shell.

Heating continues until the sun no longer strikes the window. Without this heat source, the room begins to cool. The walls and people that had been warmed, now give up their heat to the room in the form of infra-red radiation. Infra-red radiation cannot pass through window glass. The



In winter months, the sun's radiant energy streams through windows and helps with heating.



At night, heated people and objects lose heat to cold surfaces such as glass.

only way the trapped heat can escape is by means of conduction — heat lost by direct contact with a cold surface. When window draperies are closed, conduction heat loss is reduced. In this way, heat gained from the sun can be maintained for a longer period.

These facts suggest that site development and landscape planning should avoid any element that will reduce solar access to southern windows during winter months. Even during winter in northern latitudes, the south side of a building is warmed by the sun. In fact, this solar radiation is increased if there is reflection from snow.

The use of evergreen trees or tall growing shrubs must be restricted to areas where the plant's shadow does not fall on the south-facing windows during winter months. Any large plant material planned for the south side should be deciduous. Deciduous trees and shrubs lose their leaves in winter. These allow most of the sunlight to reach the wall surface.

### COUNCIL NOTES

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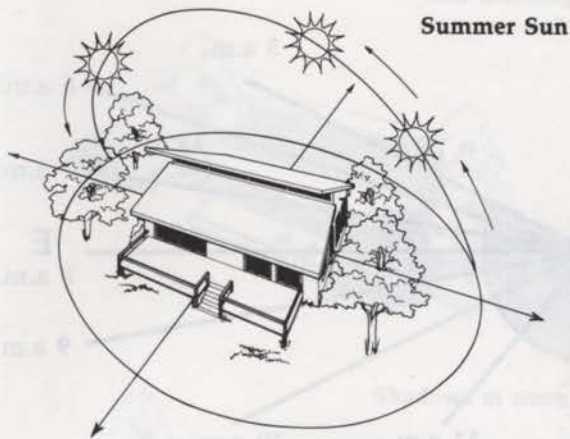
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The sun's angle is high in summer and low in winter. Wide roof overhangs can shade windows and walls in summer. In winter, the sun's path across the sky will be low enough to penetrate and warm south-facing windows.

Deciduous plants can, however, reduce the amount of solar radiation received. Sunlight passing through deciduous plants results in lowering the solar radiation potential because of the trunk, branches and twigs. Obviously, the larger or more massive the trunk, branches and twigs, the greater the reduction of sunlight penetration. The reduction of solar radiation can be as little as 25% from trees with an open character up to 60% for trees with a dense, more massive structure.

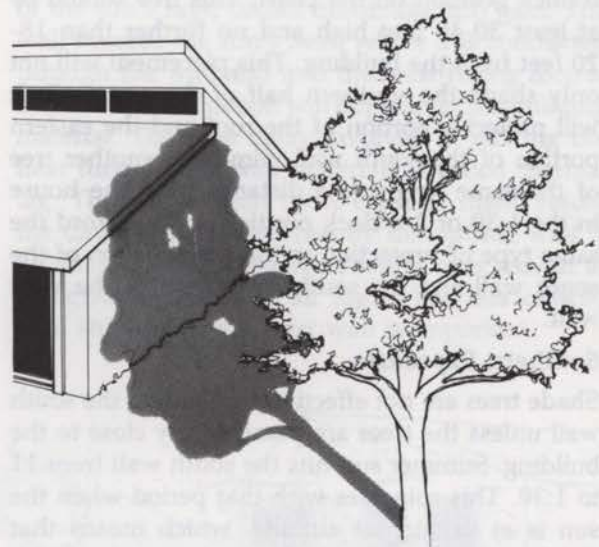
Solar geometry is critical for shading. Seasonal changes in sunrise and sunset will also influence plantings and shading. In the winter the sun rises and sets well to the south of east and west. This corridor for solar access should not be obstructed. In summer, however, the sun rises and sets to the north of the east/west line. The sun's position in summer not only radiates the south wall, but the east and west walls as well. Protecting this corridor with shading can enhance summer comfort.

## SHADING

In warm weather months, the east wall of a house is fully exposed to morning sun until 11 o'clock. The south wall and roof take direct heat from 11 to 1 o'clock. For the rest of the day, the west wall is subjected to the sun's heat. Though the heat is more intense during the middle of the day (because it is shining down from a high angle), the duration of solar exposure on east and west walls is longer. Thus, east, west and southern exposures are handled differently in terms of shading.

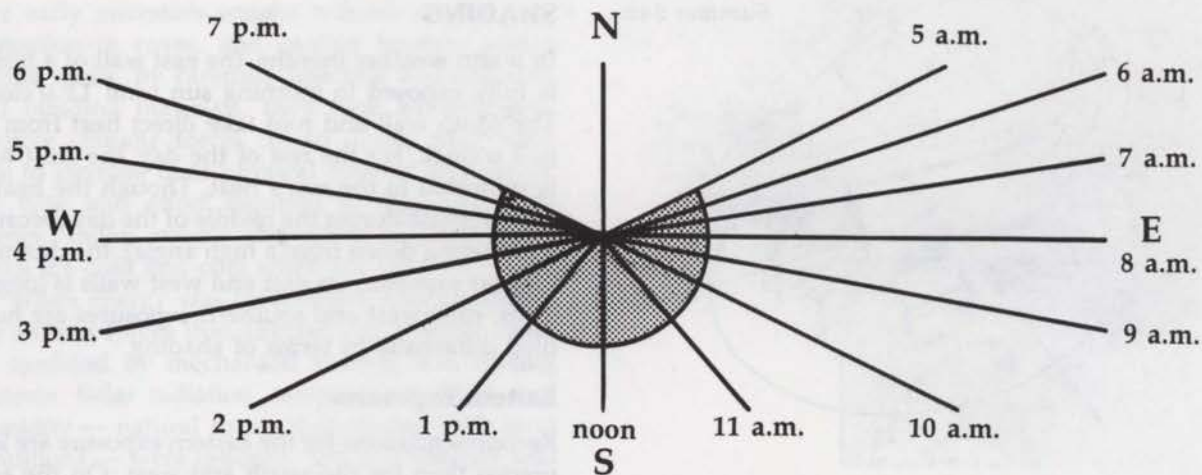
### Eastern Exposures

Recommendations for the eastern exposure are less precise than for the south and west. On the east side of a building, the heat build-up is potentially less significant. From sunrise until 9 a.m. there is not a significant build-up of heat because of overnight cooling (resulting from the previous day's heat being re-radiated into the night time sky). This night time cooling is reduced by cloud cover, as clouds trap the heat near the ground. In cooler climates, this early morning sunlight may actually be welcome. In hotter, humid climates, any morning heat, added to that which already exists, would further increase the discomfort level; thus, shading of the east wall is recommended.



The shadow cast by a large deciduous tree shades the east wall and prevents early morning heat build-up.





Use this chart to plan landscaping. A scaled drawing of your house can be placed on the chart. Orient your drawing by using the compass headings. The text will guide you in tree placement.

If early morning shading is desirable, the most effective shading will be gained by locating a tree at approximately the 6 o'clock position on the chart. Just how far from the house the tree can be located will depend on the space available. A 30-foot tree should be placed about 15-20 feet from the house to gain the maximum area of shadow. If less distance is available, a small tree closer to the building will do.

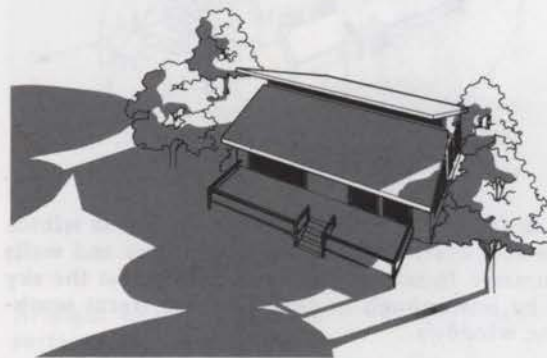
By 9 o'clock, the heat build-up of the sun has reached a level to require shade, regardless of geographical location. For this late morning shading, the tree should be located at the 10:30 to 11 o'clock position on the chart. This tree should be at least 30-40 feet high and no further than 18-20 feet from the building. This placement will not only shade the southern half of the east wall: It will protect a portion of the roof and the eastern portion of the south wall. Similarly, another tree of the same height and distance from the house in the 1:30 or 2 o'clock position would afford the same type of protection to the west portion of the south wall and the southern portion of the west wall.

### Southern Exposures

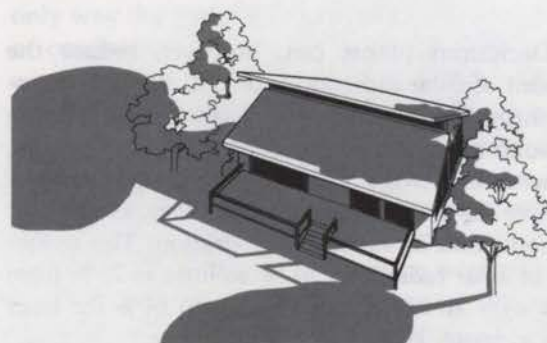
Shade trees are not effective for shading the south wall unless the trees are planted very close to the building. Summer sun hits the south wall from 11 to 1:30. This coincides with that period when the sun is at its highest altitude, which means that the length of the shadow is very shallow. The shadow will not extend very far beyond the tree crown. In this situation, the only effective shading of the south wall would be the roof overhangs which, if wide enough, will cast shade well down building wall.

During summer, trees and roof overhangs provide shade. These illustrations show how shadow patterns change during the day.

Shadows at 6 a.m.



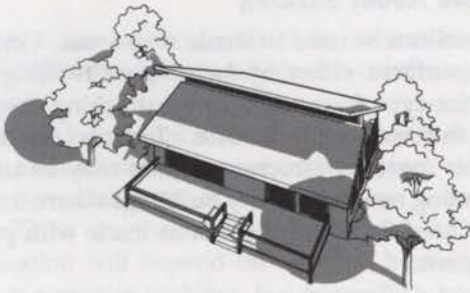
Mid-morning at 9 a.m.



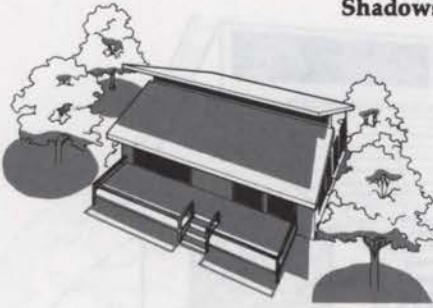
Sun shining from the 12 o'clock position strikes vertical surfaces at an oblique angle, reducing heat absorption. The sun's heat, however, is more readily absorbed when it strikes a surface at a right angle. Therefore, the noon-day sun causes less heat build-up on the south wall than does the lower altitude sun on the east or west wall. The roof area facing the south is vulnerable to major heat gains for the very reason that the sun is close to perpendicular to its surface.



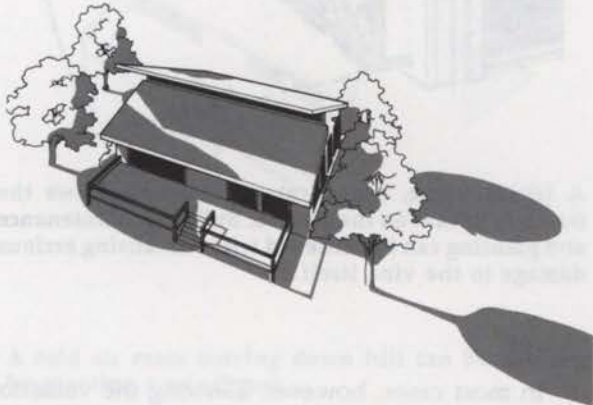
**Late morning**



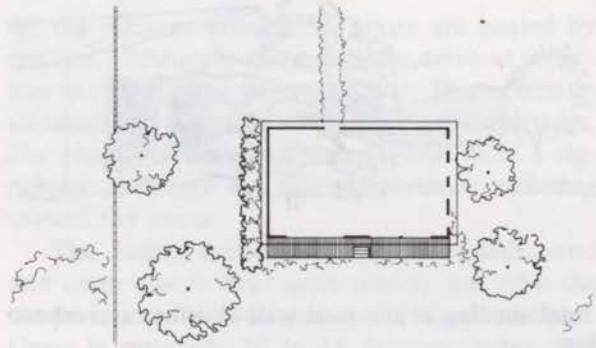
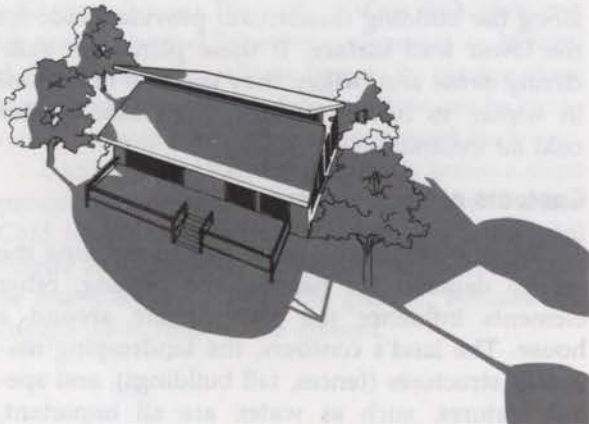
**Shadows at noon**



**Early afternoon, about 3 p.m.**



**Early evening**



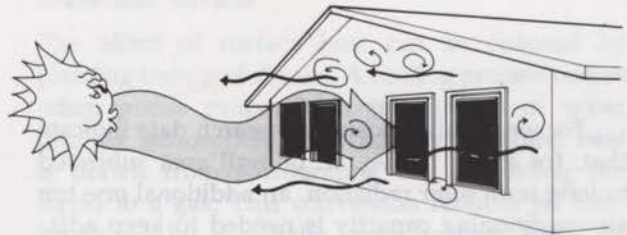
The landscape plan provides four large shade trees and additional west wall shading from dense shrubbery.

Where possible, large shade trees, close to the house, will provide shade to the roof. Such trees should carry their lower branches high enough to avoid damage to shingles. Because some deciduous trees drop a great many leaves, consideration should be given to ease of gutter clean out.

Although trees do not reduce heat build-up on the south, they may still be used for aesthetic purposes. Trees on the south, however, will reduce winter solar radiation if planted too close to the house.

### **Western Exposures**

By the time the sun reaches the western quadrant, it has gained the maximum heat build-up. This fact, combined with the nearly perpendicular angle of the sun's rays, causes maximum heat gain. The wall absorbs the sun's heat, where it is conducted through the wall and into the west-facing rooms. The rate of conduction will depend on the building material. The time delay involved in moving the heat through the wall materials is called thermal lag. Thus, it is often ten o'clock at night before the daytime heat absorbed by the outside wall is reradiated into the house. These rooms remain at a higher temperature all night. For this reason, total shading of the west wall is important.



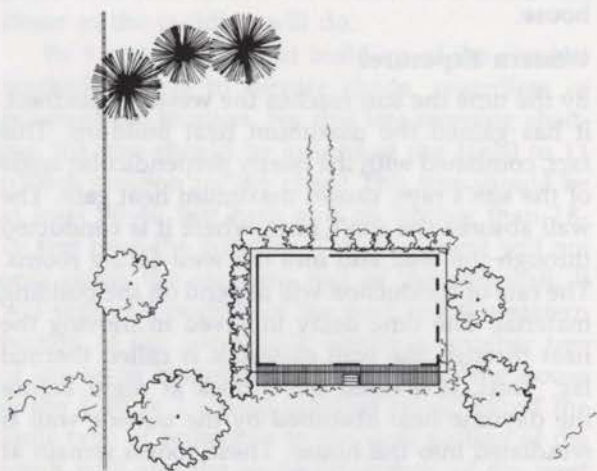
The sun's low angle late in the day heats west-facing rooms.





**Total shading of the west wall eliminates overheating.**

If space is not available for more than one tree, locate the tree at the 5 o'clock position. A large tree, located further from the house, will cast longer shadows because of the low altitude of the sun. Along with this tree, plant a linear row of four- or five-foot high shrubs or use a fence to intercept the radiation from the sun's rays passing underneath the crown of the tree. As much shading as possible on the roof area, especially in early afternoon, would also be advisable.

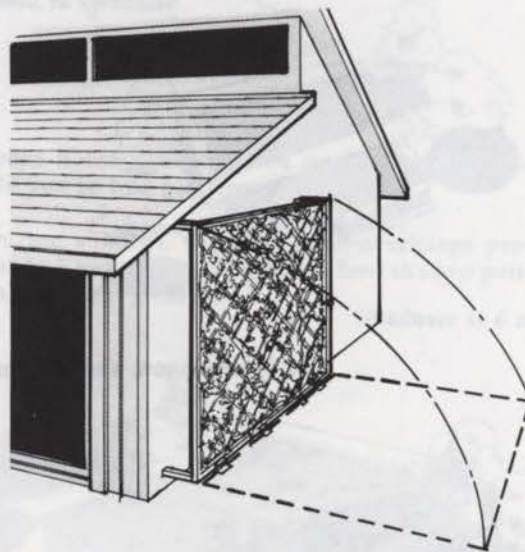


**Shrubs along the west wall are used for shading. The three large conifers and shrubbery along the north wall serve as windbreaks during winter.**

For west wall exposures, research data indicate that, for every 100 sq. ft. of wall area subjected to long term solar radiation, an additional one ton air-conditioning capacity is needed to keep adjacent rooms comfortable. Every 55 sq. ft. of glass area radiated also requires an additional one ton of air-conditioning capacity.

## More About Shading

Vines can be used to shade wall areas. Vines grow on surfaces either by twisting or twining over a lattice-type framework or by attaching themselves to the wall with tendrils. Tendrils can damage older masonry structures: Vines may be useful in shading newer masonry buildings where the bricks are hard-fired and the mortar made with portland cement.



**A lattice frame, hinged at the bottom, allows the frame to be laid on the ground. Building maintenance and painting can be achieved without causing serious damage to the vine itself.**

In most cases, however, allowing the vines to grow over a lattice framework offers several advantages. It provides a dead air space between the vine and the building, enhancing cooling and avoiding damage to frame buildings from excessive moisture.

Shrub planting, either evergreen or deciduous, along the building facade, will provide shade for the lower wall surface. If these plants are sufficiently dense and twiggy, they will also hold snow in winter, to further insulate the house against cold air infiltration.

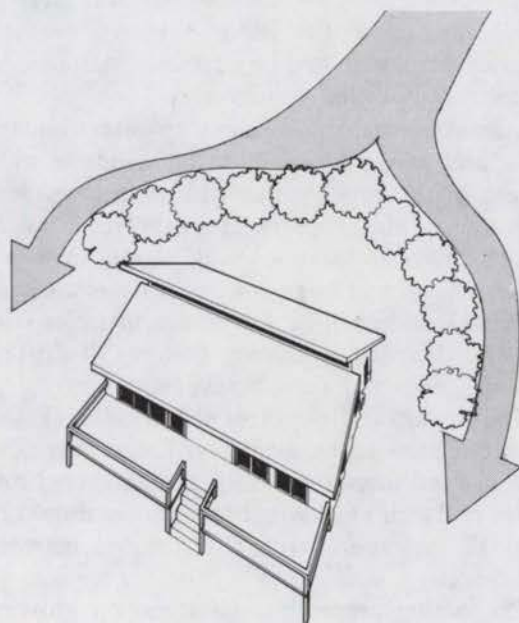
## Contours of the Landscape

While plants play a large part in reducing the energy demand for heating and cooling, other elements influence the microclimate around a house. The land's contours, the landscaping materials, structures (fences, tall buildings), and special features, such as water, are all important.



Changes in the landscape alter the microclimate and can make the difference between comfort and discomfort.

A house located on a south or southeast slope will get a lot of sun. A house on a western slope will get late afternoon sun. A house on a north slope will be on the coldest side of a hill. The ideal location will depend on whether heating or cooling is a greater problem, but generally a house located just below the crest is the best location.



A cold air mass moving down hill can be diverted by planting a windbreak.

If you live in a low area, study the cold air drainage patterns. These patterns will be the same as surface water drainage. The downhill flow of cold air, following the path of least resistance, can be easily diverted by vertical elements — hedges, dense shrubbery, walls or fences. By placing these landscape elements carefully, air flow can be channeled to avoid cold air build-up around the house.

Locating these barriers diagonally across a slope provides better protection than a horizontal barrier. Cold air would eventually overflow a horizontal barrier like a mighty waterfall. The barrier must be dense all the way to the ground, because the coldest air is next to the ground.

## Surfacing Materials

All the surfaces around the house are heated by the sun. Ultimately, these surfaces serve as reflectors or radiators of light and heat. This occurs in all seasons: It can be an advantage or disadvantage. The choice of surfacing material will have a significant influence on the temperature radiating toward the house.

The darker, denser materials of asphalt, sand and earth absorb heat more readily and raise the temperature of the surface layer of air above them. Grass is generally 10 to 14 degrees cooler than the temperature of any one of these materials, partially because of evaporation of water. As the length of grass increases, the temperatures above are even cooler. This suggests that ground covers, whose foliage may be up to 12 inches high and layered with air spaces, will provide a significant cooling during the summer heat.

Where concrete or asphalt walks, drives or patios are placed near the house, the planning for shade becomes critical. Other areas around the house should be in grass or ground cover instead of bare soil or rock mulch.

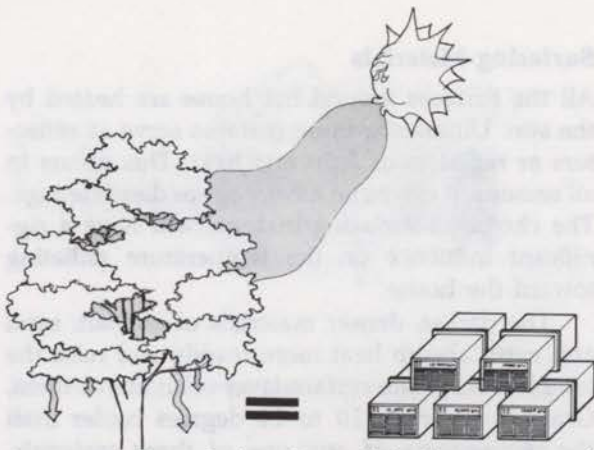
Stone or gravel will absorb heat from the sun and reradiate it toward the house. Although white stones or gravel reflect more of the sun's heat than they absorb, there remains enough heat in the stone to heat the air above it. These stone aggregate ground covers also add an annoying glare. Obviously, very dark-colored or black stones and gravel will reduce glare. Because of their dark color, however, they absorb the maximum heat from the sun. By mid-day they can be exceedingly hot.

Light reflection and reradiated heat are not always negative factors. Consider the north side of a building which is often dark and gloomy because of restricted window areas and lack of sunlight. Reflected light from fences or walls, if painted white or light colors, will add to the interior light level. Since the north side of the house is also colder in winter, these same structures can be designed to reflect accumulated heat to the north walls.

## Trees and Shrubs

The effect of surface heat can be reduced by planting trees and shrubs. A cooling process occurs when plants evaporate large amounts of water into the atmosphere. To evaporate moisture, heat is drawn from surrounding air, converting the liquid to a gas. This conversion reduces air temperature. This is called a latent heat process.



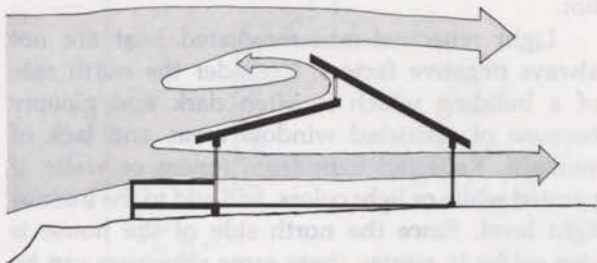


One tree, through its air-conditioning process of moisture evaporation, provides the cooling equivalent of five, 10,000 Btu air conditioners.

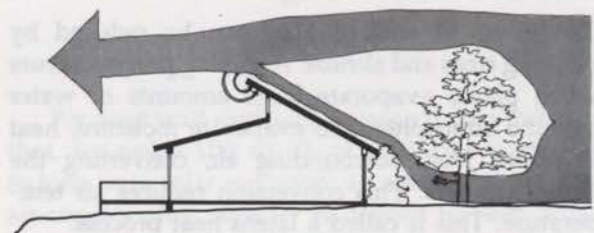
Temperatures under trees can be 15 to 25 degrees cooler. Cool air, being heavier, sinks to the ground. This is especially noticeable when the tree is located next to a paved area.

## WIND

In overheated periods, the wind can help reduce energy demands and add to human comfort. However, during underheated periods, effects of wind can greatly increase our energy consumption. When the wind ventilates an area or building, it evaporates moisture, and it cools by accelerating convective and conductive heat transfer. (Heat always moves from the warmer to the cooler surface. This transfer of heat, via air or water, is called *convective* heat transfer, while the transfer of heat between two surfaces in direct contact with one another is a *conductive* heat transfer.)



In summer, maximum air flow through the house is desirable. Convective and conductive cooling occurs as wind passes over the house.



In the wind shadow of a large evergreen, the house is protected from buffeting winter winds. The row of shrubbery lifts the wind up and over the house.

In summer, the prevailing wind and local breezes should be directed over the property. The only exception might be in hot, arid locations where the wind might result in excessive evaporation of water. During the cold months, barriers should be used to reduce the impact of the wind in order to decrease infiltration of air through cracks, crevices, and pores of surfaces, and to reduce heat transfer through convection and conduction.

## Windbreaks

Evergreen trees are the best natural material for slowing down the wind; however, properly designed fences can also be effective. Such barriers are commonly called windbreaks.

Windbreaks should be located upwind from the house and at right angles to the wind. In most sections of the country, this will be the west and north sides of the property. These directions might change for those locations with significant topographic changes or large structures nearby. Check the wind patterns near the house to make sure the wind direction is known. Patterns of drifting snow can help make this determination.

The layout and depth of the windbreak will depend on the space available. Large evergreen trees, planted three rows deep and staggered row to row, make an ideal windbreak. Rows should be 10 to 12 feet apart, with the distance between trees 6-feet.

On smaller properties, use narrower growing evergreens, such as arborvitae, junipers and yews. Hemlocks could also be considered because of their tolerance to shearing. Yearly trimming would keep their height and width to the size desired. Long term maintenance should be considered before planting, however, as these trees, and many plantings, can become overgrown.

The greatest protection from a windbreak will fall within a zone that is equal to the height of the windbreak multiplied by five. Significant protection extends to an area 10-15 times the height of the windbreak's trees.

In cities, the best protection from wind might be a fence. Since six feet is the maximum height permitted for fences, the zone of protection will be reduced. For maximum protection, fences should be close to the areas needing protection. A good windbreak fence is constructed of vertical boards that are relatively narrow, with space between to allow the air to move through, but at a reduced speed.